

BATTERY-OPERATED LIGHTING DEVICE

The present invention relates to a lighting device that operates on a rechargeable battery pack.

5

BACKGROUND OF THE INVENTION

Electrical appliance that operates on a rechargeable battery pack requires the use of a battery pack of a specified design and a specified operating voltage. Examples of such electrical appliance are power hand tools such as drills, and lighting devices such as torch lights. For promotion, electric hand drills are sometimes sold with a torch light as a gift, in which case the torch light is designed to operate on the same battery pack as the drill.

In the same series or design, electric hand drills are available in different driving powers, which determines the operating voltage of the battery pack needed. It is therefore necessary to produce torch lights of different operating voltages to go with electric hand drills of the same operating voltage. This complicates the manufactory, inventory control as well as packaging of such products.

25

The invention seeks to mitigate or at least alleviate such a problem by providing an improved battery-operated lighting device.

SUMMARY OF THE INVENTION

According to the invention, there is provided a battery-  
5 operated lighting device for use with any one of a  
plurality of rechargeable battery packs, each pack having  
a pair of terminals and a different operating voltage. The  
lighting device comprises a casing having first and second  
parts, a lighting unit including a light bulb provided at  
10 the first casing part, and a battery chamber formed at the  
second casing part for receiving at least part of and  
locating said any one battery pack. The light bulb has an  
optimum operating voltage. A pair of electrical contacts  
is located in the chamber for making electrical connection  
15 with respective terminals of said battery pack located by  
the chamber. The casing houses an electronic voltage  
regulating circuit that has an input and an output in  
electrical connection with the contacts and the light bulb  
respectively. The circuit is arranged to regulate the  
20 voltage of said battery pack down to substantially the  
optimum operating voltage of the light bulb for operating  
the light bulb.

Preferably, the chamber has an opening through which said  
25 part of the battery pack is insertable into the chamber.  
The opening has a periphery of a shape and size  
substantially the same as that of an adjacent periphery of  
said part of the battery pack for matching therewith when

said battery pack is located by the chamber.

More preferably, the outer surface of the casing forming the chamber is arranged to lie substantially flush with that of said battery pack when said battery pack is located by the chamber.

In a specific construction, the casing has a lower end that forms the chamber, said chamber having a bottom opening through which said part of the battery pack is insertable into the chamber, with the rest of said battery pack acting as a weighted base for the overall torch light.

more specifically, the casing has an upper end that supports the lighting unit and includes a middle section between the upper and lower ends that is shaped to form an upright handgrip.

In a preferred embodiment, the voltage regulating circuit is implemented based on an integrated circuit chip to provide a substantially constant output voltage that is the optimum operating voltage of the light bulb, irrespective of an input voltage falling within a predetermined range.

More preferably, the voltage regulating circuit includes a feedback loop connected from the output back to the

integrated circuit chip, which loop is arranged to provide a signal indicative of the level of the output voltage to enable the chip to maintain the output voltage at a substantially constant level.

5

It is preferred that the predetermined range of input voltage is substantially from 9.6V to 18.0V DC.

More preferably, the operating voltages of said battery packs are substantially 9.6V, 12.0V, 13.2V, 14.4V, 15.6V, 16.8V and 18.0V.

It is preferred that the optimum operating voltage of the light bulb is substantially 9.3V DC.

15

#### BRIEF DESCRIPTION OF DRAWINGS

The invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

25

Figure 1 is a left side view of an embodiment of a battery-operated lighting device in accordance with the invention, with a battery pack connected thereto;

Figure 2 is a rear view of the lighting device and battery pack of Figure 1;

Figure 3 is a left side view of the battery pack of Figure 1;

Figure 4 is a cross-sectional right side view of the lighting device and battery pack of Figure 1; and

Figure 5 is a circuit diagram of an operating circuit of the lighting device of Figure 1.

10 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring initially to Figures 1 to 4 of the drawings, there is shown a battery-operated lighting device in the form of a torch light 100 embodying the invention, which  
15 light 100 comprises a plastics casing 110 having upper and lower ends 112 and 114, a lighting unit 120 provided at the upper casing end 112, and a battery chamber 150 formed at the lower casing end 114. The casing 110 includes a middle section 116 that is shaped to form an upright  
20 handgrip 118, at the upper end of which a spring-loaded trigger 130 is located to control the lighting unit 120.

The lighting unit 120 incorporates a light bulb 122 and is pivotably connected to the upper end 112 of the casing 110  
25 by means of a hinge 124, such that it may be turned up and down relative to the casing 110 to point at different angles. The light bulb 122 has an optimum operating voltage of about 9.3V DC.

The handgrip 118 is hollow and is divided by a horizontal partition 119 into upper and lower parts 118A and 118B.

5 The upper part 118A houses a press switch 132 which is coupled to the trigger 130 for actuation thereby to switch the light bulb 122 on and off. Also housed in the this casing part 118A are a printed circuit board 134 mounting an electronic voltage regulating circuit 140, and a pair of electrical contact strips 136. The contact strips 136  
10 are located to pass through the partition 119 into the top end of the lower casing part 118B, on opposite left and right sides thereof and opposing each other. The lower part 118B expands in cross-section downwardly to form the battery chamber 150.

15 The battery chamber 150 has a bottom opening 152 having a substantially rectangular periphery in the form of a rim 152A. Internally, the chamber 150 consists of a relatively tall and narrow inner (upper) part 150A and a relatively  
20 shallow and wide outer (lower) part 150B, said outer part 150B defining the bottom opening 152. The bottom opening 152 includes, on its left and right sides, a pair of opposed hooks 154.

25 The torch light 100 works on a rechargeable battery pack 200 that is originally designed for powering an electrical power hand tool such as a hand drill. The battery pack 200 has a cuboidal body 210 which includes an upper surface

211 having a generally rectangular periphery 211A and houses a bank of battery cells 212. The battery body 210 includes a stem 214 projecting upwards from the upper surface 211, at the uppermost end and on opposite left and right sides of which a pair of battery terminals 216 is located. The battery body 210 further includes, on opposite left and right sides thereof, a pair of spring-loaded catches 218.

10 The battery pack 200 is to be inserted upwards into the chamber 150 of the torch light 100, for locating thereby. In doing so, the battery stem 214 extends fully into the inner chamber part 150A, with the upper surface 211 being received within the outer chamber part 150B and closing  
15 the bottom opening 152 of the chamber 150. As soon as the battery pack 200 is parked against the lower casing end 114, the catches 218 of the former snap with respective hooks 154 of the latter, whereby the battery pack 200 is locked connected.

20

The upper periphery 211A of the battery body 210 has substantially the same shape and size as the rim 152A of the bottom opening 152, such that the battery pack 200, or more precisely its body 210, forms a matching, weighted  
25 base of the overall torch light 100 for the torch to stand on. In particular, the outer surfaces of the torch casing 110 and battery body 210 across their junction lie substantially flush with each other. Depression of both

catches 218 allows detachment of the battery pack 200.

The battery pack 200 can be any one available from a line or series of battery packs having different predetermined operating voltages that fall within the range from 9.6V to 18.0V DC and are typically 9.6V, 12.0V, 13.2V, 14.4V, 15.6V, 16.8V and 18.0V. Apart from the difference in operating voltage, all battery packs 200 of the same line have substantially the same physical shape and size, at least insofar as their stems 214 (for internal connection) and the upper peripheries 211A of their bodies 210 (for external matching) are concerned, such that any one of the battery packs 200 can fit the torch light 100. The battery packs 200 are originally designed to drive respective electric hand drills belonging to the same line of products, according to their operating voltages.

Reference is now made to Figure 5. In order to cater for the variation in the operating voltage of the battery packs 200, the voltage regulating circuit 140 is designed to provide a constant output voltage, irrespective of the value of the input voltage applied by any one of the battery packs 200 in use that falls within a predetermined range. The constant output voltage is the optimum operating voltage of the light bulb 122, i.e. 9.3V DC. The predetermined input voltage range covers the operating voltages of all compatible battery packs 200, i.e. from 9.6V to 18.0V DC.



The voltage regulating circuit 140 has a pair of positive and negative input terminals 141 and 142 which are connected to the contact strips 136 respectively for subsequent connection to the respective terminals 216 of the battery pack 200. The circuit 140 includes a pair of positive and negative output terminals 143 and 144 which are connected to the light bulb 122.

10 The circuit 140 is implemented based on an integrated circuit chip IC1 that is connected at its VIN and VOUT pins in series across the positive terminals 141 and 143. The VIN pin is connected to the positive input terminal 141 via the switch 132 for manual control, behind which a capacitor C1 is connected across the input terminals 141 and 142. The VOUT pin is connected to the positive output terminal 143 via an inductor L1 for smoothing the output current, behind which a capacitor C2 is connected across the output terminals 143 and 144. The negative terminals 142 and 144 are connected together as the ground.

The chip IC1 includes a GND pin connected direct to the ground, and an ON/OFF pin that is connected to the ground via a capacitor C3. The capacitor C3 serves to slow down the rise of the output current at the VOUT pin such that the light bulb 122 will have a soft start over the initial few seconds. A pair of resistors R2 and R3 is connected in series across the output terminals 143 and 144, having a

common node to which an OADJ pin of the chip IC1 is connected. The circuit 140 includes a diode D1 that is connected at its anode to the ground and at its cathode to the VOUT pin.

5

In operation, the chip IC1 converts a DC input voltage, in the range from 9.6V to 18.0V, applied at the VIN pin into voltage pulses appearing at the VOUT pin. The pulsating output voltage is then smoothed by the inductor L1 and the  
10 capacitor C2, whose mean level (value) is fed by means of the resistors R1 and R2 back to the chip IC1 at its OADJ pin. The resistors R1 and R2 and their connection to the chip IC1 constitutes a feedback loop connected from the output terminals 143 and 144 back to the chip IC1. The  
15 feedback loop serves to provide a signal indicative of the actual level of the output voltage to enable the chip IC1 to maintain the output voltage at the desired level.

More specifically, the chip IC1 will adjust the mark-to-space (or on-to-off) ratio of the voltage pulses in order  
20 to provide a substantially constant, regulated DC output voltage across the output terminals 143 and 144, i.e. 9.3V, for operating the light bulb 122. During the off states, i.e. intervals between adjacent voltage pulses,  
25 the diode D1 and inductor L1 serve to maintain at least a small output current to ensure that the light bulb 122 has a smooth operation and is not subject to inrush current, such that the bulb 122 will have a better reliability or

longer operating life.

With the use of the voltage regulating circuit 140, the torch light 100 is capable of working on any one of the battery packs 200 which have the same body design but different operating voltages. The battery packs 200 may be originally made for driving respective electrical power hand tools of the same product line. Insofar as the torch light 100 is concerned, it can be operated universally by any compatible battery pack 200 whose operating voltage can differ (within a certain range).

As being compatible with more than one battery pack or battery voltage, the torch light of the subject invention is convenient to use. For this reason, the torch light can be sold with any one of electrical power hand tools whose driving powers are different, to share the same battery pack.

The invention has been given by way of example only, and various modifications of and/or alterations to the described embodiment may be made by persons skilled in the art without departing from the scope of the invention as specified in the appended claims.